ENVIRONMENTAL PROGRAM INFORMATION

Introduction

The vitrified high-level radioactive waste (HLW) presently stored at the Western New York Nuclear Service Center (WNYNSC) on the West Valley Demonstration Project (WVDP or Project) premises is the by-product of the reprocessing of spent nuclear fuel during the late 1960s and early 1970s, when the WNYNSC was leased by Nuclear Fuel Services, Inc. (NFS) for a commercial nuclear fuel reprocessing facility.

As the WNYNSC is no longer an active nuclear fuel reprocessing facility, the environmental monitoring program focuses on measuring radioactivity and chemicals associated with the residual by-products of NFS operations and the Project's HLW treatment and low-level radioactive waste (LLW) management operations. The following information about the operations at the WVDP and about radiation and radioactivity will be useful in understanding the activities of the Project and the terms used in reporting the results of environmental testing measurements.

Radiation and Radioactivity. Radioactivity is a characteristic of some elements that have unstable atomic nuclei which spontaneously disintegrate or "decay" into atomic nuclei of another isotope or element. (See *isotope* [p. GLO-5] in the Glossary.) The nuclei decay until only a stable, nonradioactive isotope remains. Depending on the isotope, this process can take anywhere from less than a second to billions of years.

As atomic nuclei decay, radiation is released in three main forms: alpha particles, beta particles, and gamma rays. By emitting energy or particles, the nucleus moves toward a less energetic, more stable state.

Alpha Particles. An alpha particle, released by decay, is a fragment of a much larger nucleus. It consists of two protons and two neutrons (similar to the nucleus of a helium atom) and is positively charged. Compared to beta particles, alpha particles are relatively large and heavy and do not travel very far when ejected by a decaying nucleus. Alpha radiation, therefore, is easily stopped by a thin layer of material such as paper or skin. However, if radioactive material is ingested or inhaled, the alpha particles released inside the body can damage soft internal tissues because all of their energy is absorbed by tissue cells in the immediate vicinity of the decay. An example of an alpha-emitting radionuclide is the uranium isotope with an atomic weight of 232 (uranium-232). Uranium-232 was in the HLW mixture at the WVDP as a result of a thorium-based nuclear fuel reprocessing campaign conducted by NFS and has been previously detected in liquid waste streams.

Radioactivity

Atoms that emit radiation are called radionuclides. Radionuclides are unstable isotopes of an element that have the same number of protons but different numbers of neutrons, resulting in different atomic masses. For example, the element hydrogen has two stable isotopes, hydrogen-1 (H^1) and hydrogen-2 (H^2) (deuterium), and one radioactive isotope, hydrogen-3 (H^3) (tritium). The numbers following the element's symbol identify the atomic mass, which is the number of protons plus neutrons in the nucleus. Thus, H^1 has one proton and no neutrons, H^2 has one proton and one neutron, and H^3 has one proton and two neutrons.

When radioactive atoms decay by emitting radiation, the daughter products that result may be either radioactive or stable. Generally, radionuclides with high atomic numbers, such as uranium-238 and plutonium-239, have many generations of radioactive progeny. For example, the radioactive decay of plutonium-239 creates uranium-235, thorium-231, protactinium-231, and so on through 11 progeny until only the stable isotope lead-207 remains.

Radionuclides with lower atomic numbers often have no more than one daughter. For example, strontium-90 has one radioactive daughter, yttrium-90, which finally decays into stable zirconium; cobalt-60 decays directly to stable nickel with no intermediate nuclide.

The time required for half of the radioactivity of a radionuclide to decay is referred to as the radionuclide's half-life. Each radionuclide has a unique half-life; both strontium-90 and cesium-137 have half-lives of approximately 30 years while plutonium-239 has a half-life of 24,400 years. Knowledge of radionuclide half-lives is often used to estimate past and future inventories of radioactive material. For example, a 1.0-millicurie source of cesium-137 in 2000 would have measured 2.0 millicuries in 1970 and will be 0.5 millicuries in 2030.

Radiation emitted by radionuclides may consist of electromagnetic rays, such as x-rays and gamma rays, or charged particles, such as alpha and beta particles. A radionuclide may emit one or more of these radiations at characteristic energies that can be used to identify them.

Background Radiation

Background radiation is always present, and everyone is constantly exposed to low levels of such radiation from both naturally-occurring and man-made sources. In the United States the average total annual exposure to low-level background radiation is estimated to be about 360 millirem (mrem) or 3.6 millisieverts (mSv). Most of this radiation, approximately 295 mrem (2.95 mSv), comes from natural sources. The rest comes from medical procedures, consumer products, and other man-made sources (NCRP Report 93, 1987). (See Figure 2-9 [p. 2-27] in Chapter 2, Environmental Radiological Program Information.)

Background radiation includes cosmic rays, the decay of natural elements, such as potassium, uranium, thorium, and radon, and radiation from sources such as chemical fertilizers, smoke detectors, and televisions. Actual doses vary depending on such factors as geographic location, building ventilation, and personal health and habits.

Beta Particles. A beta particle is an electron that results from the breakdown of a neutron in a radioactive nucleus. Beta particles are small compared with alpha particles, travel at a higher speed (close to the speed of light), and can be stopped by a material such as wood or aluminum less than an inch thick. If beta particles are released inside the body they do much less damage than an equal number of alpha particles. This is because beta particles are smaller, faster, and have less of a charge; beta particles deposit energy in tissue cells over a larger volume than alpha particles. Strontium-90, a fission product, is an example of a beta-emitting radionuclide. (See *fission* [p. GLO-4] in the Glossary.) Strontium-90 is found in the stabilized supernatant.

Gamma Rays. Gamma rays are high-energy "packets" of electromagnetic radiation, called photons, that are emitted from the nucleus. They are similar to x-rays but generally have a shorter wavelength and therefore are more energetic than x-rays. If the alpha or beta particle released by the decaying nucleus does not carry off all the energy generated by the nuclear disintegration, the excess energy may be emitted as gamma rays. If the released energy is high, a very penetrating gamma ray is produced that can be effectively reduced only by shielding consisting of several inches of a dense material, such as lead, or of water or concrete several feet thick. Although large amounts of gamma radiation are dangerous, gamma rays are also used in many lifesaving medical procedures. An example of a gamma-emitting radionuclide is barium-137m, a short-lived daughter product of cesium-137. Both barium-137m and its precursor, cesium-137, are major constituents of the WVDP high-level radioactive waste.

Measurement of Radioactivity. The rate at which radiation is emitted from a disintegrating nucleus can be described by the number of decay events or nuclear transformations that occur in a radioactive material over a fixed period of time. This process of emitting energy, or radioactivity, is measured in curies (Ci) or becquerels (Bq).

The curie is based on the decay rate of the radionuclide radium-226 (Ra-226). One gram of radium-226 decays at the rate of 37 billion nuclear disintegrations per second (3.7E+10 d/s), so one curie equals 37 billion nuclear disintegrations per second. One becquerel equals one decay, or disintegration, per second. (See the Scientific Notation section at the back of this report [UOM-2] or p. 1-5 of this chapter for information on exponentiation [i.e., the use of "E" to mean the power of 10].)

Very small amounts of radioactivity are sometimes measured in picocuries. A picocurie is one-trillionth (1E-12) of a curie, equal to 3.7E-02 disintegrations per second (3.7E-02 Bq), or 2.22 disintegrations per minute.

Measurement of Dose. The amount of energy absorbed by the receiving material is measured in rads (radiation absorbed dose). A rad is 100 ergs of radiation energy absorbed per gram of material. (An erg is the approximate amount of energy necessary to lift a mosquito one-sixteenth of an inch.) "Dose" is a means of expressing the amount of energy absorbed, taking into account the effects of different kinds of radiation.

Alpha, beta, and gamma radiation affect the body to different degrees. Each type of radiation is given a quality factor that indicates the extent of human cell damage it can cause compared with equal amounts of other ionizing radiation energy. Alpha particles cause twenty times as much damage to internal tissues as x-rays, so alpha radiation has a quality factor of 20, compared to gamma rays, x-rays, or beta particles, all of which have a quality factor of 1.

The unit of dose measurement to humans is the rem (roentgen-equivalent-man). (See *roentgen* and *rem* [p. GLO-9] in the Glossary.) The number of rem are equal to the number of rad multiplied by the quality factor for each type of radiation. Dose can also be expressed in sieverts. One sievert equals 100 rem.

Environmental Monitoring Program Overview

Exposure of human beings to radioactivity would be primarily through air, water, and food. At the WVDP all three pathways are monitored, but air and surface water pathways are the two primary near-term means by which radioactive material can move off-site.

The geology of the site (types of soil and bedrock), the hydrology (location and flow of surface water and groundwater), and meteorological characteristics of the site (wind speed, patterns, and direction) are all considered in evaluating potential exposure through the major pathways.

The on-site and off-site monitoring program at the WVDP includes measuring the concentration of alpha and beta radioactivity, conventionally referred to as "gross alpha" and "gross beta," in air and water effluents. Measuring the total alpha and beta radioactivity from key locations, which can be done within a matter of hours, produces a comprehensive picture of on-site and off-site levels of radioactivity from all sources. For a U.S. Department of Energy (DOE) site such as the WVDP, frequent updating and tracking of the overall levels of radioactivity in effluents is an important tool in maintaining acceptable operations.

More detailed measurements are also made for specific radionuclides. Strontium-90 and cesium-137 are measured because they have been previously detected in WVDP waste materials. Radiation from other important radionuclides such as tritium or iodine-129 is not sufficiently energetic to be detected by gross measurement techniques, so these must be analyzed separately using methods with greater sensitivity. Heavy elements such as uranium, plutonium, and americium require special analysis to be measured because they exist in such small concentrations in the WVDP environs.

The radionuclides monitored at the Project are those that might produce relatively higher doses or that are most abundant in air and water effluents. Because man-made sources of radiation at the Project have been decaying for more than thirty years, the monitoring program does not routinely include short-lived radionuclides, that is, isotopes with a half-life of less than two years, which would have less than 1/1,000 of the original radioactivity remaining. (See Appendix B [pp. B-1 through B-47] for the schedule of samples and radionuclides measured and Appendix K, Table K-1 [p. K-3] for a listing of the half-lives of radionuclides measured in WVDP samples and related DOE protection standards, such as the derived concentration guides [DCGs]. See also the discussion of DCGs [*facing page*].)

Data Reporting. Because the decay of radioactive atoms is a random process, there is an inherent uncertainty associated with all measurements of environmental radioactivity. This can be demonstrated by repeatedly measuring the number of atoms that decay in a radioactive sample over some fixed period of time. The result of such an experiment would be a range of values for which the average value would provide the best indication of how many radioactive atoms were present in the sample.

However, in actual practice an environmental sample usually is measured for radioactivity only once. The inherent uncertainty of the measurement, then, stems from the fact that it cannot be known whether the result that was obtained from one measurement is higher or lower than the "true" value.

Derived Concentration Guides

A derived concentration guide (DCG) is defined by the DOE in DOE Order 5400.5 as the concentration of a radionuclide in air or water that, under conditions of continuous exposure by one exposure mode (i.e., ingestion of water, immersion in air, or inhalation) for one year, would result in an effective dose equivalent of 100 mrem (1 mSv) to a "reference man." (See "reference man" in the Glossary [p.GLO-9].) These concentrations – DCGs – are used as reference screening levels to enable WVDP personnel reviewing effluent and environmental data to decide if further investigation is needed. (See Table K-1, Appendix K [p. K-3] for a list of DCGs.)

For liquid effluent screening purposes, the percentages of the DCGs for all radionuclides present are summed. If the total is less than 100%, then the effluent released complies with the DOE guideline. DCGs are also compared with radionuclide concentrations from these sources to verify that Best Available Technology (BAT) standards for treatment of water are being met.

The DOE provides DCGs for airborne radionuclides in locations where members of the public could, over an extended period of time, breathe air containing contaminants. DCGs are only applicable to radionuclides in air breathed by members of the public. DCGs may be used as a basis for screening concentrations from air emission points.

DOE Orders and federal regulations require that the hypothetical dose to the public from facility effluents be estimated using specific computer codes. (See Dose Assessment Methodology [p. 2-29] in Chapter 2, Environmental Radiological Program Information.) Doses estimated for WVDP activities are calculated using actual site data and are not related directly to summed DCG values. Dose estimates for liquid effluents are based on the product of radionuclide quantities released and the site-specific dose equivalent effects for that radionuclide. Although airborne DCGs are used for comparison purposes, the more stringent U.S. Environmental Protection Agency (EPA) National Emission Standards for Hazardous Air Pollutants (NESHAP) regulate Project airborne effluents at the point of release. For a consistent guide to relative concentrations, both air and water sampling results are compared with DCGs throughout this report.

The term *confidence interval* is used to describe the range of measurement values above and below the test result within which the "true" value is expected to lie. (See *confidence interval* in the Glossary [p. GLO-2].) This interval is derived statistically. The width of the interval is based primarily on a predetermined confidence level, that is, the probability that the confidence interval actually encompasses the "true" value. The WVDP environmental monitoring program uses a 95% confidence level for all radioactivity measurements and calculates confidence intervals accordingly.

The confidence interval around a measured value is indicated by the plus-or-minus (±) value following the result (e.g., 5.30±3.6E-09 µCi/mL), with the exponent of 10^{-9} expressed as "E-09." Expressed in decimal form, the result 5.30±3.6E-09 would be 0.00000000530±0.0000000036 µCi/mL. A sample measurement expressed this way is correctly interpreted to mean "there is a 95% probability that the concentration of radioactivity in this sample is between 1.7E-09 µCi/mL and 8.9E-09 µCi/mL." (See also Scientific Notation [p. UOM-2] at the end of this report.) If the confidence interval for the measured value includes zero (e.g., 5.30±6.5E-09 µCi/mL), the value is considered to be below the detection limit. The values listed in tables of radioactivity measurements in the appendices include the confidence interval regardless of the detection limit value.

In general, the detection limit is the minimum amount of constituent or material of interest detected by an instrument or method that can be distinguished from background and instrument noise. Thus, the detection limit is the lowest value at which a sample result shows a statistically positive difference from a sample in which no constituent is present. (Maximum and minimum values in data sets showing positive results have been set in boldface type in the data appendices at the back of this report; the key to this convention is described at the beginning of each appropriate appendix.)

Nonradiological data conventionally are presented without an associated uncertainty and are expressed by the detection limit prefaced by a "less-than" symbol (<) if that analyte was not measurable. (See also Data Assessment and Reporting [p. 5-7] in Chapter 5, Quality Assurance.)

Units of measure, as used in this document, are listed on p. UOM-1. In the text, traditional radiological units (e.g., rem, rad, curie, roentgen) are presented first, followed by Systeme Internationale (S.I.) units. Nonradiological measurements are presented in English units, with the metric equivalent noted in parentheses. A conversion chart for comparing traditional and S.I. radiological units and English and metric nonradiological units is presented on p. UOM-2.

Changes in the 2002 Environmental Monitoring Program. Several modifications to the environmental sampling and surveillance network were made in 2002 to better reflect current facility status.

• Sampling at air emission point ANLAUNV, the contaminated clothing laundry, was discontinued.

• The modified (July 2002) State Pollutant Discharge Elimination System (SPDES) permit for the site included analytical changes for sampling point WNSP001 and added monitoring requirements for internal monitoring point WNSP01B.

See Appendix B for a detailed summary of the program changes (p. B-iv) and the sample points and parameters measured in 2002 (pp. B-1 through B-47).

Vitrification Overview

High-level radioactive waste from NFS operations was originally stored in two of four underground tanks (tanks 8D-2 and 8D-4). The waste in 8D-2, the larger of the active tanks, had settled into two layers: a liquid (the supernatant) and a precipitate layer on the tank bottom (the sludge). To solidify the HLW, WVDP engineers designed and developed a process of pretreatment and vitrification.

Pretreatment Accomplishments. The supernatant (in tank 8D-2) was composed mostly of sodium and potassium salts dissolved in water. Radioactive cesium in solution accounted for more than 99% of the total radioactivity in the supernatant. During pretreatment, sodium salts and sulfates were separated from the radioactive constituents in both the liquid portion of the high-level waste and the sludge layer in the bottom of the tank.

Pretreatment of the supernatant began in 1988. The integrated radwaste treatment system (IRTS) reduced the volume of the HLW needing vitrification by producing low-level radioactive waste stabilized in cement. The supernatant was passed through zeolite-filled ion exchange columns in the supernatant treatment system (STS) to remove more than 99.9% of the radioactive cesium. The resulting liquid was then concentrated by evaporation in the liquid waste treatment system (LWTS). This low-level radioactive concentrate was blended with cement in the cement solidification system (CSS) and placed in 71-gallon (269-liter) steel drums. The cement-stabilized waste form has been accepted by the U.S. Nuclear Regulatory Commission (NRC).

The steel drums are stored in an on-site aboveground vault, the drum cell. (See Fig. A-1 [p. A-3].) Processing of the supernatant was completed in 1990, with approximately 20,000 drums of cement-stabilized waste produced.

The sludge that remained was composed mostly of iron hydroxide. Strontium-90 accounted for most of the radioactivity in the sludge. Pretreatment of the sludge layer in HLW tank 8D-2 began in 1991. Five specially designed 50-foot-long pumps were installed in the tank to mix the sludge layer with water to produce a uniform sludge blend and to dissolve the sodium salts and sulfates that would interfere with vitrification. After mixing and allowing the sludge to settle, processing of the wash water through the IRTS began. Processing removed radioactive constituents for later solidification into glass, and the wash water containing salt was then stabilized with cement in the CSS.

Sludge washing was completed in 1994 after approximately 765,000 gallons (2.9 million liters) of wash water had been processed. About 8,000 drums of cement-stabilized wash water were produced. In January 1995, high-level radioactive waste liquid stored in tank 8D-4 was transferred to tank 8D-2. (Tank 8D-4 contained thorium reduction extraction [THOREX] high-level radioactive waste, which had been produced by a single reprocessing campaign of a special fuel containing thorium that had been conducted from November 1968 to January 1969 by NFS.) The resulting mixture was washed and the wash water was processed. The IRTS processing of the combined wash waters was completed in May 1995.

In all, through the supernatant treatment process and the sludge wash process, more than 1.7 million gallons (6.4 million liters) of liquid had been processed by the end of 1995, producing a total of 19,877 drums of cemented LLW. These drums are stored in the drum cell.

As one of the final steps, the ion-exchange material (zeolite) used in the IRTS to remove radioactivity was blended with the washed sludge before being transferred to the vitrification facility for blending with the glass-formers. In 1995 and early 1996 final waste transfers to HLW tank 8D-2 were completed in preparation for vitrification.

Preparation for Vitrification. Nonradioactive testing of a full-scale vitrification system was conducted from 1984 to 1989. In 1990 all vitrification test equipment was removed to allow installation of shield walls for remote radioactive operations. The walls and shielded tunnel connecting the vitrification facility to the former reprocessing plant were completed in 1991. The slurry-fed ceramic melter was assembled, bricked, and installed in 1993, and the cold chemical building was completed, as was the sludge mobilization system that transferred the high-level waste to the melter. This system was tested in 1994. Several additional major systems components also were installed in 1994: the canister turntable, which positioned the stainless steel canisters as they were filled with molten glass; the submerged bed scrubber, which cleaned gases produced by the vitrification process; and the transfer cart, which moved filled canisters to the storage area.

Nonradiological testing (“cold” operations) of the vitrification facility began in 1995, and the first canister of nonradiological glass was produced. The

WVDP declared its readiness to proceed with the necessary equipment tie-ins of the ventilation and utility systems to the vitrification facility building and tie-ins of the transfer lines to and from the HLW tank farm and the vitrification facility. In this closed-loop system, the transfer lines connected to multiple common lines so that material could be moved among all the points in the system.

High-level waste vitrification began in 1996. Phase I, which saw the majority of the high-level liquid waste vitrified, was completed in mid-1998. Phase II, removing and vitrifying residual radioactivity, was completed during 2002. (See Completion of Vitrification [*below*].)

2002 Activities at the WVDP

The WVDP's environmental management system is an important factor in the environmental monitoring program and the accomplishment of its mission. Significant components, initiatives, and pertinent information about the work accomplished at the WVDP in 2002 are summarized below.

Completion of Vitrification. In 2002, eleven high-level waste canisters were produced. Since the beginning of vitrification in 1996 through calendar year 2002, more than 12.2 million cesium/strontium curies were transferred to the vitrification facility and 275 high-level waste canisters were filled. Two additional low-level canisters were generated as a result of evacuating the melter. The slurry-fed ceramic melter was shut down in September 2002.

Tank Cleaning and Characterization. West Valley Nuclear Services Company (WVNSCO) has successfully concluded the characterization project for the waste tanks 8D-1 and 8D-2 and prepared the final radionuclide inventory report. This project encompassed the application of many new and innovative technologies to perform in-situ characterization of radionuclide inventories for the tanks, including the gamma camera, beta gamma detector, solid-state track recorder neutron dosimetry, and a fixed-waste burnishing sampler. Mathematical modeling activities performed by Pacific Northwest National Laboratory (PNNL) and URS, which incorporated all newly collected field data and instrument calibration results, were completed in 2002. This characterization program focused on the quantification of residual activity within tank 8D-2 following wall-washing activities and developing an inventory of the STS components that are located within tank 8D-1.

Additionally, radioisotopic characterization of the residual waste heels remaining in tanks 8D-3 and 8D-4 and the STS valve aisle was completed in 2002. Radioisotopic inventory reports were prepared that provide a curie inventory for use with performance assessment modeling.

The successes and lessons learned from the characterization project have been shared with the DOE's Office of Environmental Management (DOE-EM) through the Tank Focus Area (TFA) program.

Decontamination. Initial decontamination efforts in the main plant are focusing on the process mechanical cell (PMC) and the general purpose cell (GPC) to place the cells in a safer configuration for future facility decommissioning. After a readiness assessment was completed, decontamination work began in the PMC during September 2001.

In 2002, the DOE completed its readiness assessment for work to cleanup the head-end cells. During this period, a shield window in the GPC was refurbished and cleanup operations in this cell were initiated. Removal of waste from the PMC also continued and upgrades to the scrap removal room (SRR) were completed to support the cleanup operations.

Planning was also started for cleanup of waste in the product purification cell (PPC)-south and extraction cell No. 2 (XC-2). Work to gain access to the PPC-south began in 2002.

Fuel storage racks, canisters, and debris were removed from the fuel receiving and storage (FRS) pool. Draining of the pool, decontamination of the pool walls, and shipment of the FRS debris for disposal were also initiated. Water drained from the pool was treated prior to discharge at outfall WNSP001 in accordance with DOE Order 5400.5 and SPDES permit requirements.

Preparation for Spent Fuel Shipping. During 2001, the spent nuclear fuel stored at the West Valley site was safely loaded for shipment to the Idaho National Engineering and Environmental Laboratory (INEEL). In 2002, the fuel was monitored and maintained in a secure transport-ready state awaiting shipment.

Remote-Handled Waste Facility Construction. As part of project operations, various contaminated materials/components have been removed from the former process building and are in storage awaiting disposal. In addition, as efforts increase toward eventual decommissioning, additional materials and components will be removed from the waste tank farm and the former process building. Before these waste materials can be shipped for disposal, they have to be characterized, sorted, processed as necessary, and packaged to meet regulatory requirements for transportation. The remote-handled waste facility (RHWF), currently under construction, will be used to process and package these highly contaminated, high-activity, solid radioactive wastes. Construction of the RHWF started in September 2000 and continued throughout 2002. The facility is scheduled to begin operations by calendar year 2004.

Environmental Management of Aqueous Radioactive Waste. Water containing radioactive material from site process operations is collected and treated in the low-level waste treatment facility (LLWTF). (Water from the sanitary system, which does not contain added radioactive material, is managed in a separate system.)

The treated process water is held, sampled, and analyzed before it is released through a New York SPDES-permitted outfall. In 2002, over 13.7 million gallons (52.0 million liters) of water were treated in the LLWTF system, which includes the low-level waste treatment building (LLW2) and associated holding lagoons, and discharged through outfall 001, the lagoon 3 weir. The discharge waters contained an estimated 24.7 millicuries of gross alpha plus gross beta radioactivity. Comparable releases during the previous seventeen years averaged about 33 millicuries per year. The 2002 release was about 75% of this average. (See Overview of Water Effluent and Ambient Surface Water Monitoring [p. 2-4] in Chapter 2.)

Approximately 0.13 curies of tritium were released in WVDP liquid effluents in 2002 – about 11% of the seventeen-year average of 1.23 curies.

Environmental Management of Airborne Radioactive Emissions. Ventilated air from the various WVDP facilities is sampled continuously during operation for both particulate matter and for gaseous radioactivity. In addition to monitors that alarm if particulate matter radioactivity increases above pre-set levels, the sample media are analyzed in the laboratory for the specific radionuclides that are present in the radioactive materials being handled.

Air used to ventilate the facilities where radioactive material cleanup processes are being conducted is passed through filtration devices before being emitted to the atmosphere. These filtration

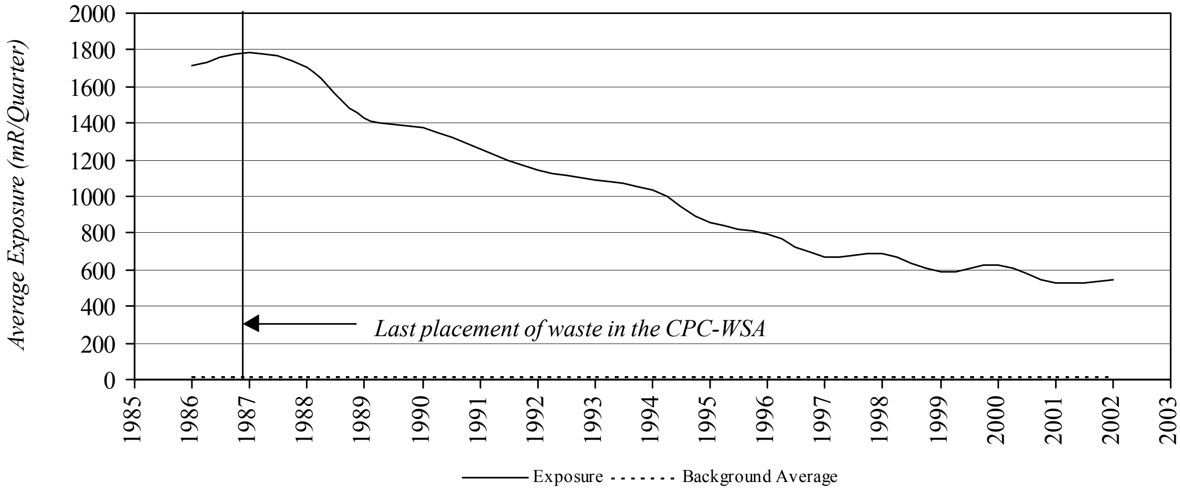

Figure 1-1. Annual Average Exposure at the CPC-WSA (DNTLD24)

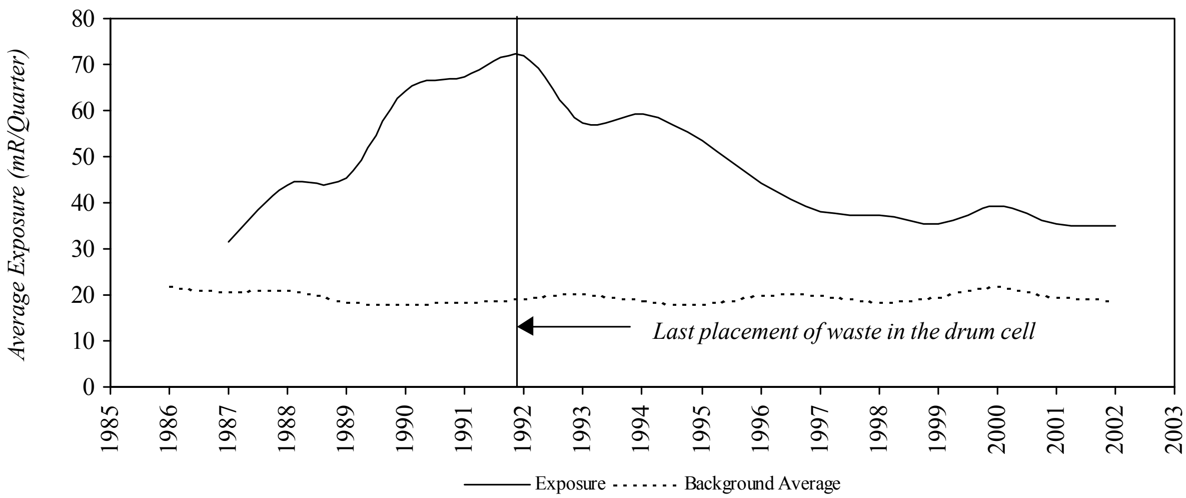

Figure 1-2. Annual Average Exposure at the Drum Cell (DNTLD36)

devices are generally more effective for particulate matter than for gaseous radioactivity. For this reason, facility air emissions tend to contain a greater amount of gaseous radioactivity (e.g., tritium and iodine-129) than radioactivity associated with particulate matter (e.g., strontium-90 and cesium-137). However, gaseous radionuclide emissions still remain so far below the most restrictive regulatory limit for public safety that additional treatment technologies beyond those already provided by, for example, the vitrification off-gas treatment system, are not necessary.

Gaseous radioactivity emissions from the main plant in 2002 included approximately 70.9 millicuries of tritium (as hydrogen tritium oxide [HTO]) and 0.45 millicuries of iodine-129. (See Chapter 2 [p. 2-32] for a discussion of iodine-129 emissions from the main plant stack.) As expected, these 2002 values are quite low in comparison to values from 1997, a year in which the vitrification system was in operation for the entire year at a relatively high rate of production and tritium and iodine-129 emissions were 140 millicuries and 7.43 millicuries, respectively.

Particulate matter radioactive emissions from the main plant in 2002 included approximately 0.07 millicuries of gross beta-emitting radioactivity and 0.002 millicuries of gross alpha-emitting radioactivity. In 1997, beta-emitting and alpha-emitting radioactivity emissions were 0.4 millicuries and 0.001 millicuries, respectively.

Environmental Management of Radiological Exposure. Radiological exposures measured at on-site monitoring locations DNTLD24, located near the chemical process cell waste storage area (CPC-WSA), and DNTLD36, located near the drum cell, have shown steady decreases for several years. (See Fig. A-10 [p. A-12] for the locations of these two monitoring points.) Exposure data for these two monitoring locations are shown in Figures 1-1 and 1-2 (p. 1-10).

The beginning of the long-term steady decrease in exposure at DNTLD24 correlates well with the cessation of placement of waste containers in the CPC-WSA in 1987 and with the decay of the mix of isotopes in the stored waste. The decreases noted at DNTLD36 can be attributed to the cessation of the placement of waste drums in the drum cell as well as the decay of the mix of isotopes in the stored waste over time and to the revised stacking plan initiated in 1990, which changed the arrangement of waste and shield drums in the drum cell.

Unplanned Radiological Releases. There were no unplanned airborne or liquid radiological releases on-site or to the off-site environment from the Project in 2002.

NRC-Licensed Disposal Area (NDA) Interceptor Trench and Pretreatment System. Radioactively contaminated n-dodecane in combination with tributyl phosphate (TBP) was discovered at the northern boundary of the NDA in 1983, shortly after the DOE assumed control of the WVDP site. Extensive sampling and monitoring through 1989 revealed the possibility that the n-dodecane/TBP could migrate. To contain migration of this subsurface radioactive organic contaminant, an interceptor trench and liquid pretreatment system (LPS) were built.

As in previous years, no water containing n-dodecane/TBP was encountered in the trench and no water or n-dodecane/TBP was treated by the LPS in 2002. Approximately 433,000 gallons (1,640,000 liters) of radiologically contaminated water were collected from the interceptor trench and transferred to the LLWTF for treatment during the year. Results of surface and groundwater monitoring in the vicinity of the trench are discussed in Chapter 2 under South Plateau Surface Water and NDA Interceptor Trench (p. 2-8) and in Chapter 4 under Results of Monitoring at the NDA (p. 4-15).

Waste Minimization Program. The WVDP formalized a waste minimization program in 1991 to reduce the generation of LLW, mixed waste, and hazardous waste. This program is a comprehensive and continual effort to prevent or minimize pollution, with the overall goal of reducing health and safety risks, protecting the environment, and complying with all federal and state regulations. (See also the Environmental Compliance Summary, Waste Minimization and Pollution Prevention [p. ECS-5] and p. 1-18 of this chapter.)

Pollution Prevention Awareness Program. The WVDP's Pollution Prevention (P2) Awareness Program is a significant part of the Project's waste minimization program. The goal of the program is to make all employees aware of the importance of pollution prevention both at work and at home.

A crucial component of the P2 Awareness Program at the WVDP is the Pollution Prevention Coordinators group. This group communicates, shares, and publicizes prevention, reduction, reuse, and recycling information to all departments at the WVDP. The P2 Coordinators identify and facilitate the implementation of effective source-reduction, reuse, recycling, and procurement of recycled products. The WVDP employs an incentive-based program to encourage waste stream reduction/elimination, energy savings, and affirmative procurement. This program has fostered cost savings and avoidances resulting from waste minimization and P2 activities.

Waste Management. The WVDP continued accomplishments in reducing and eliminating waste generated by site activities. Reductions in the generation of low-level radioactive waste, mixed waste, hazardous waste, industrial wastes, and sanitary waste such as paper, plastic, wood, and scrap metal were targeted.

Waste minimization and recycling activities during 2002 resulted in approximately $10,000,000 in savings. To accomplish this, the following items were recycled:

- toner cartridges - 1.17 tons (1.06 metric tons)
- batteries - 2.46 tons (2.23 metric tons)
- paper and paper products - 72.4 tons (65.7 metric tons)
- scrap metals - 323 tons (293 metric tons)

Low-Level Radioactive Waste Shipping Program. The WVDP initiated the LLW shipping program in 1997 to reduce the inventory of legacy waste stored on-site. More than 145,000 cubic feet (4,110 cubic meters) of radioactive waste have been safely shipped for off-site disposal since the program was instituted. In the past, most of the LLW shipped from the WVDP was sent to commercial disposal facilities. However, in July 2001 the WVDP was approved to ship LLW to the Nevada Test Site (NTS), a DOE facility.

The LLW planned for shipment during CY 2002 included 19 boxes of Fuel Receiving and Storage Facility (FRS) debris, 13 resin containers from the old LLWTF (O2 building), and 2 vitrification expended materials processing (VEMP) boxes to NTS. A shipment of approximately 7,500 cubic feet (212 cubic meters) of LLW from FRS facility decontamination to Envirocare of Utah was also planned. However, work to ensure the integrity of FRS debris containers caused the waste shipments to be pushed to the end of CY 2002 and the beginning of CY 2003. A total of 3,900 cubic feet (111 cubic meters) of FRS debris was shipped to NTS for disposal in CY 2002.

National Environmental Policy Act Activities. Under the National Environmental Policy Act (NEPA), the DOE is required to consider the overall environmental effects of its proposed actions or federal projects. The President's Council on Environmental Quality established a screening system of analyses and documentation that requires each proposed action to be categorized according to the extent of its potential environmental effect. The levels of documentation include categorical exclusions (CXs), environmental assessments (EAs), and environmental impact statements (EISs).

Categorical exclusions evaluate and document actions that will not have a significant effect on the environment. Environmental assessments evaluate the extent to which the proposed action will affect the environment. If a proposed action

West Valley Citizen Task Force

In addition to the public comment process required by the National Environmental Policy Act, the New York State Energy Research and Development Authority (NYSERDA), with participation from the DOE, formed the West Valley Citizen Task Force in January 1997. The mission of the Task Force is to provide advice on the completion of the West Valley Demonstration Project and cleanup, closure, and/or long-term management of the facilities at the site. The Task Force process has helped illuminate the various interests and concerns of the community, increased the two-way flow of information between the site managers and the community, and provided an effective way for the Task Force members to establish mutually agreed upon recommendations for the site managers to consider in their decision-making process.

has the potential for significant effects, an environmental impact statement is prepared that describes proposed alternatives to an action and explains the effects.

Facility maintenance, decontamination activities, and minor projects that support HLW vitrification are documented and submitted for approval as CXs, although EAs occasionally are necessary for larger-scale activities.

In December 1988 the DOE published a joint Notice of Intent with the New York State Energy Research and Development Authority (NYSERDA) to prepare an environmental impact statement for the completion of the WVDP and closure of the facilities at the WNYNSC.

The draft EIS, which describes the potential environmental effects associated with Project completion and various site closure alternatives, was completed in 1996 and released without a preferred alternative for a six-month public review and comment period. Having met throughout 1997 and 1998 to review alternatives presented in the draft EIS, the Task Force (see inset [*at left*]) issued the West Valley Citizen Task Force Final Report (July 29, 1998). This report provided recommendations and advice on the development of a preferred alternative. The Task Force continues to meet and discuss issues related to Project completion and site closure decision making.

Because the NRC is authorized by the West Valley Demonstration Project Act to prescribe decommissioning criteria for the WVDP, from 1998 until early 2002 the NRC worked to develop those decommissioning criteria through a series of draft policy papers and public meetings.

After the federal administration change in 2001, the DOE and NYSERDA continued efforts to reach agreement on a preferred alternative and agency responsibilities for decommissioning and/or long-term stewardship at the WVDP and the WNYNSC. Also in 2001, DOE formally initiated its plan to revise the scope of the 1996 draft EIS by splitting that scope into two separate documents. The decision-making process has been separated into two phases by revising the scope of the 1996 draft EIS. Re-scoping will allow two separate environmental impact statements – one for near-term waste management decision making and one for final decommissioning and/or long-term stewardship decision making.

DOE published a Federal Register Notice of Intent (NOI) on March 26, 2001 (66 FR 16447) formally announcing its rescoping plan and preparation of the waste management EIS. A draft EIS for waste management is being prepared for public review and comment.

DOE also published an Advance NOI on November 6, 2001 (66 FR 56090) announcing its commitment to begin work, in cooperation with NYSERDA, on the Decommissioning and/or Long-Term Stewardship EIS. DOE and NYSERDA are joint lead agencies on this EIS.

In January 2002 the NRC announced that it was issuing its final policy statement establishing the criteria of its existing license termination rule as the decommissioning criteria for the WVDP.

On February 1, 2002, the NRC issued its *Decommissioning Criteria for the West Valley Demonstration Project (M-32) at the West Valley Site; Final Policy Statement* in the Federal Register (67 FR 5003). The Final Policy Statement applies the NRC's License Termination Rule (10 CFR Part 20, Subpart E) as the decommissioning criteria for the WVDP and as the decommissioning goal for the entire WNYNSC.

In October 2002, DOE invited the EPA, the NRC, and the New York Department of Environmental Conservation (NYSDEC) to be formal cooperating agencies on the Decommissioning and/or Long-Term Stewardship EIS. All three agencies accepted the DOE's invitation.

The DOE and NYSERDA continued negotiations during 2002 in an effort to reach agreement on a preferred alternative and agency responsibilities for decommissioning and/or long-term stewardship at the WVDP and WNYNSC.

Self-Assessments. Self-assessments continued to be conducted in 2002 to review the management and effectiveness of the WVDP environmental protection and monitoring programs. Results of these self-assessments are evaluated and corrective actions are tracked through to completion. Overall results of these self-assessments found that the WVDP continued to implement quality requirements and in some cases improve the quality of the environmental protection and monitoring program. (See the Environmental Compliance Summary [p. ECS-18] and Chapter 5, Quality Assurance [p. 5-6].)

Occupational Safety and Environmental Training. The safety of personnel who are involved in industrial operations under DOE cognizance is protected by standards mandated by DOE Order 440.1A, Worker Protection Management for DOE Federal and Contractor Employees, which directs compliance with specific Occupational Safety and Health Act (OSHA) requirements. This act governs diverse occupational hazards ranging from electrical safety and protection from fire to the handling of hazardous materials. The purpose of OSHA is to maintain a safe and healthy working environment for employees.

Hazardous waste operations and emergency response regulations require that employees at treatment, storage, and disposal facilities, particularly those who may be exposed to health and safety hazards during hazardous waste operations, receive training appropriate to their job function and responsibilities. The WVDP environmental, health, and safety training matrix identifies the specific training requirements for such employees.

The WVDP provides a basic twenty-four-hour hazardous waste operations and emergency response training. (Emergency response training includes spill response measures and controlling contamination of groundwater.) In 2002, the WVDP trained decontamination workers and their supervisors according to the 40-hour program for hazardous waste operations and emergency response to meet the additional OSHA training requirements of a cleanup site. The additional training will provide workers with information and techniques for decontamination operations.

Training programs also contain information on waste minimization, pollution prevention, and the WVDP environmental management program. Besides this standard training, employees working in radiological areas receive additional training on subjects such as understanding radiation and radiation warning signs, dosimetry, and respiratory protection. In addition, qualification standards for specific job functions at the site are required and maintained. These programs have evolved into a comprehensive curriculum of knowledge and skills necessary to maintain the health and safety of employees and ensure the continued compliance of the WVDP.

Medical emergencies on-site are handled by the WVDP Emergency Medical Response Team. This team consists of on-site professional medical staff, volunteer New York State-certified emergency medical technicians, and main plant operators who are First Responders.

Any person working at the WVDP who has a personal photo badge receives general employee training that covers health and safety, emergency response, and environmental compliance issues. All visitors to the WVDP receive a site-specific briefing on safety and emergency procedures before being admitted to the site.

Voluntary Protection Program STAR Status. On May 5, 2000 the WVDP received Voluntary Protection Program (VPP) STAR status, the highest safety award given within OSHA or the DOE. This prestigious award was granted in recognition of the WVDP's excellent worker safety and health programs. (See also the Environmental Compliance Summary [p. ECS-16].)

WVNSCO has reaffirmed its commitment to DOE's VPP. During the 2002 reporting period, the VPP was reviewed as part of the annual Integrated Safety Management System (ISMS) review and the DOE completed an on-site review of the VPP program and has been recertified as a DOE-VPP STAR site. At the annual VPP Participants National Conference, WVNSCO was awarded the DOE's Star of Excellence Award. The WVDP is the only site to receive this award for two consecutive years. This award is given to sites with outstanding safety programs.

Environmental Management System (EMS) Implementation. The Project's environmental management system provides the basic policy and direction for work at the WVDP through procedures that support proactive management, environmental stewardship, and the integration of appropriate technologies throughout all aspects of the work at the WVDP.

The National Environmental Performance Track is designed to recognize and encourage top environmental performers – those who go beyond compliance with regulatory requirements to attain levels of environmental performance and management that benefit people, communities, and the environment.

The logo identifies those facilities that qualify for Achievement Track membership. Achievement Track facilities can participate in a peer exchange network to share experience, benchmark each other's performance, share information on successful practices and strategies, and receive recognition for their work at state and local levels. The WVDP was awarded charter membership in this program.

The WVDP EMS satisfies the requirements of the new DOE Order 450.1, Environmental Protection Program. (See the discussion of new DOE Order 450.1 in the Compliance Summary [p. ECS-1].) The EMS is also in compliance with the Code of Environmental Management Principles (CEMP) for federal agencies and International Organization for Standardization (ISO) 14001, Environmental Management Systems: Specification for Guidance and Use, which is being implemented worldwide. The CEMP was developed by the EPA in response to Executive Order 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements, in order to serve as the basis for responsible environmental management. Following the principles and performance objectives of the CEMP helps to ensure that a federal facility's environmental performance is proactive, flexible, cost-effective, and sustainable. The WVDP has maintained its charter membership in the EPA's National Environmental Performance Track program for implementation of this EMS. (See inset on p. 1-15.) The most recent self-assessment by WVNSCO, performed in August 2002, verified that the EMS continues to be effectively implemented at the WVDP.

Integrated Safety Management System (ISMS) Implementation. A plan to integrate environmental, safety, and health (ES&H) management programs at the WVDP was developed and initiated at the WVDP during 1998. During development of the ISMS, the enhanced work planning program (EWP) was identified as an integral part of the ISMS and a sitewide work review group was established to review work plans, identify ES&H concerns, and specify practices that ensure that work is performed safely.

Implementation of an ISMS at the WVDP, including the EWP, was verified by the DOE Ohio Field Office in November 1998. The most recent self-assessment by WVNSCO, performed in August 2002, verified that the ISMS continues to be effectively implemented at the WVDP. An annual ISMS review by the DOE occurred in November 2002 and confirmed the results of the WVNSCO self-assessment.

Performance Measures

Performance measures can be used to evaluate effectiveness, efficiency, quality, timeliness, productivity, safety, or other areas that reflect achievements related to organization or process goals, and can be used as a tool to identify the need to institute changes.

The performance measures applicable to operations conducted at the WVDP, discussed here, reflect process performance related to wastewater treatment in the LLW treatment facility, the identification of spills and releases, the reduction in the generation of wastes, the potential radiological dose received by the maximally exposed off-site individual, and the transfer of HLW to the vitrification system.

Radiation Doses to the Maximally Exposed Off-Site Individual. One of the most important pieces of information derived from environmental monitoring program data is the potential radiological dose to an off-site individual from on-site activities. As an overall assessment of Project activities and the effectiveness of the As-Low-As-Reasonably-Achievable (ALARA) concept, the effective radiological dose to the maximally exposed off-site individual is an indicator of well-managed radiological operations. The effective dose equivalents for air effluent emissions, liquid effluent discharges, and other liquid releases (such as swamp drainage) from 1993 through 2002 are graphed in Figure 1-3 (*facing page*). Note that the sum of these values is well below the DOE standard of 100 mrem per year. These consistently low results indicate that radiological activities at the site are well-controlled. (See also Table 2-6 [p. 2-31] in Chapter 2, Environmental Radiological Program Information.)

State Pollutant Discharge Elimination System (SPDES) Permit Limit Exceptions. Effective operation of the site wastewater treatment facilities is indicated by compliance with the applicable discharge permit limitations. Approximately sixty parameters are monitored regularly as part of the SPDES permit requirements. The analytical results are reported to NYSDEC via Discharge Monitoring Reports, required under the SPDES program.

Although the goal of the low-level waste treatment facility and wastewater treatment facility operations is to maintain effluent water quality consistently within the permit requirements, occasionally SPDES permit limit exceptions do occur. All SPDES permit limit exceptions are evaluated to determine their cause and to identify corrective measures.

A Water Task Team, composed of WVDP personnel with expertise in wastewater engineering, treatment plant operations and process monitoring, and National Pollutant Discharge Elimination System (NPDES)/SPDES permitting and compliance, was formed in 1995 to address the causes of these exceptions.

The Water Task Team's efforts produced three consecutive years with no permit limit exceptions. In 2001, one permit limit exception for total recoverable lead occurred at outfall 008 – the french drain for the LLWTF lagoon system. There were no SPDES exceptions during 2002. (See Fig. 1-4 [p. 1-18].)

Although exceptions are not always related to operating deficiencies, corrective actions may include improved operation or treatment techniques. In 1997 the WVDP notified NYSDEC of the presence of mercury in the influent wastewater to the LLWTF and of its likely presence at outfall 001 at concentrations below the detectable level of 0.2 µg/L. In 1998 and 1999 an increase in the mer-

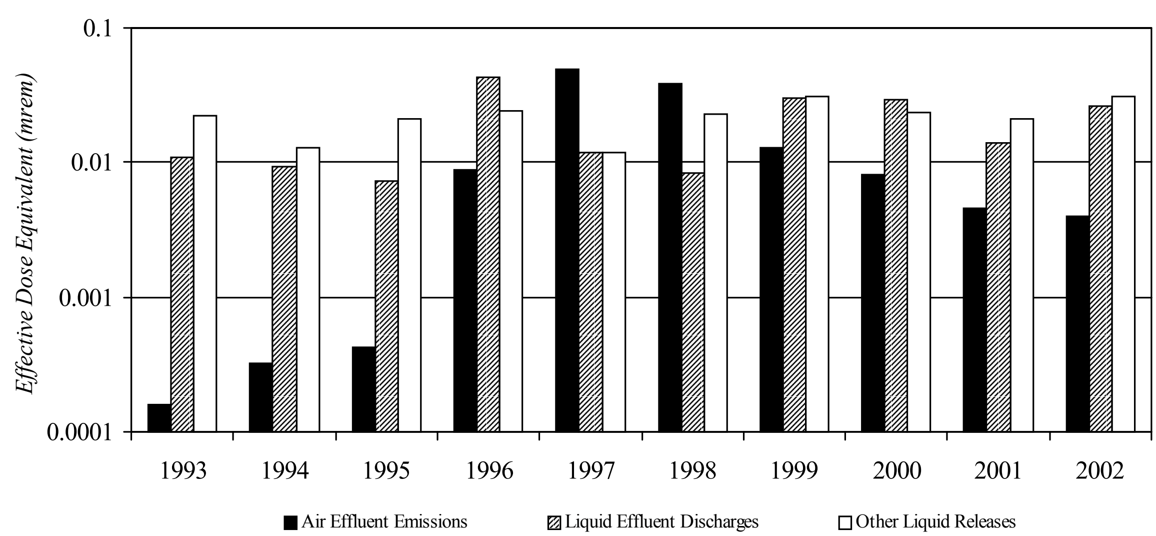

Figure 1-3. Annual Effective Dose Equivalent to the Maximally Exposed Off-Site Individual

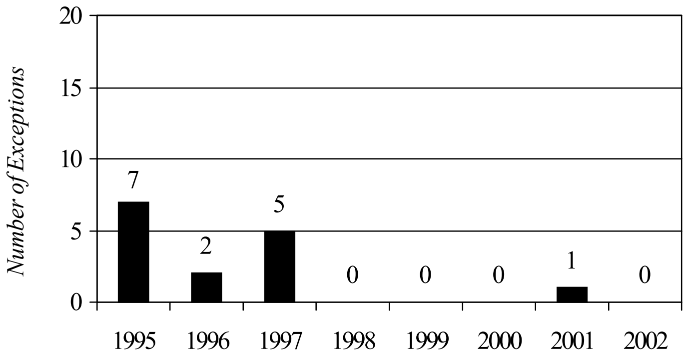

Figure 1-4. Yearly SPDES Permit Exceptions

cury concentration was observed in process wastewater from the LWTS evaporator, water that is eventually treated at the LLWTF. The LWTS evaporator processes residual radioactive wastewater from the HLW-processing and supernatant treatment operations.

During 2000, an engineering report and plans and specifications for a mercury pretreatment system, designed to remove mercury from the LWTS process water, were prepared by the WVDP and approved by NYSDEC. The system was subsequently installed and processing of LWTS wastewater through this system began in January 2001.

Waste Minimization and Pollution Prevention. In 2002 the WVDP continued its program of reducing and eliminating the amount of waste generated from site activities. Emphasis on good business practices, source-reduction, and recycling continued to reduce the generation of low-level radioactive waste, mixed waste, hazardous waste, industrial wastes, and sanitary wastes such as paper, glass, plastic, wood, and scrap metal.

To demonstrate the effectiveness of the waste minimization program, a graph of the percentage of waste reduction achieved above the annual goal for each category is presented in Figure 1-5 (*facing page*) for CYs 1995 through 2002.

The WVDP set the following cumulative nonvitrification waste-reduction goals for fiscal year 2002: a 70% reduction in the generation of LLW, a 75% reduction in the generation of mixed waste, a 65% reduction in the generation of hazardous waste, a 55% reduction in the generation of industrial waste, and a 70% reduction in the generation of sanitary waste. These goals were based on quantities of routine waste generated in 1993. (As of fiscal year 2002, all WVDP pollution prevention goals are in alignment with the DOE's pollution prevention goals, which are now based on a federal fiscal year.)

All but two of these goals were exceeded during fiscal year 2002. LLW generation was reduced by 69%, missing the established goal of 70% by just 1%. Mixed waste generation was reduced by 99%, hazardous waste by 93%, industrial waste by 70%, and sanitary waste generation was reduced by 68%, slightly below the goal of 70%.

A number of waste streams have been tracked over this period. Note that the low-level radioactive waste figures from 1995 include the volume of drummed waste produced in the cement solidification system. Hazardous waste and industrial waste volumes have been tracked separately for vitrification-related and nonvitrification-related waste streams since vitrification began in 1996. To maintain historical comparability, the percentages in Figure 1-5 include only the nonvitrification portions of these two waste streams.

Spills and Releases. Chemical spills greater than the applicable reportable quantity must be reported immediately to NYSDEC, the National Response Center, and other agencies as required. There were no reportable chemical spills during 2002.

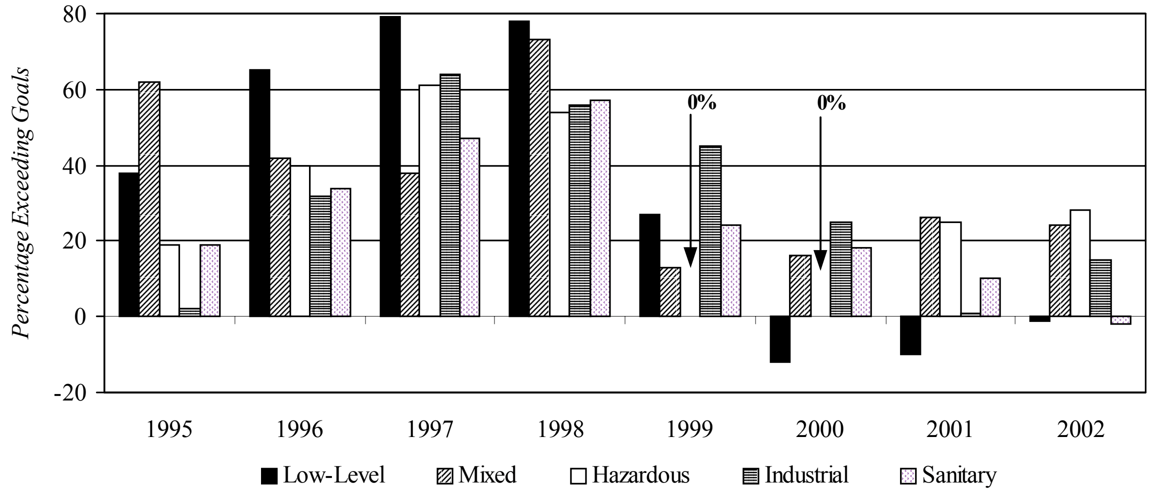

Figure 1-5. Percentage of Waste-Reduction-Exceeding Goals

Petroleum spills greater than 5 gallons – or of any amount that travel to waters of the state – must be reported immediately to the NYSDEC spill hotline and entered in the WVDP's monthly log. There were no reportable petroleum spills in 2002. Figure 1-6 (*below*) is a bar graph of immediately reportable spills from 1995 to 2002.

Prevention is the best means of protection against oil, chemical, and hazardous substance spills or releases. WVDP employees are trained in applicable standard operating procedures for equipment that they use, and best management practices have been developed that identify potential spill sources and preventive measures that will reduce the likelihood of releases. Spill training, notification, and reporting policies have also been developed to emphasize the responsibility of each employee to report spills immediately upon discovery. This first-line reporting helps to ensure that spills will be properly documented and mitigated in accordance with applicable regulations.

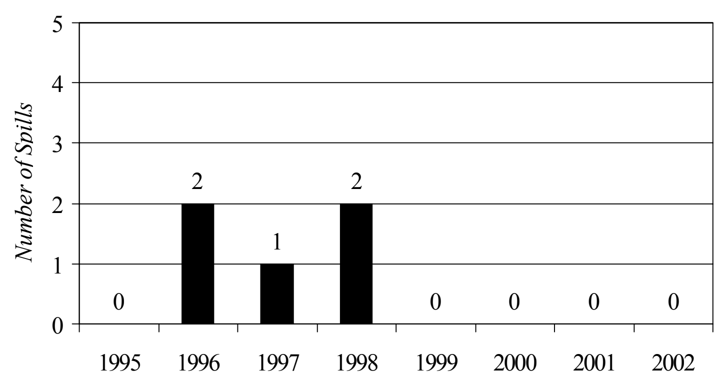

Figure 1-6. Number of Immediately Reportable Spills or Releases

Vitrification. To safely solidify the HLW in borosilicate glass, the high-level waste sludge was transferred in batches from the storage tank to the vitrification facility. After transfer, the waste was solidified into a durable glass as it was cast into stainless-steel canisters for safe storage and future transport to a federal repository.

On June 10, 1998, the WVDP marked completion of the Project's production phase (Phase I) of high-level waste processing, during which 210 canisters were filled with vitrified waste. Phase II, vitrifying the HLW residuals, began in 1998 and continued through September 2002.

An additional 65 canisters have been filled in Phase II, eleven of which were filled in 2002. A total of 275 canisters of immobilized waste, containing more than 12.2 million curies of strontium and cesium, have been generated.

Figure 1-7 (*below*) shows the number of curies transferred to the vitrification facility from 1996 through 2002.

In addition to the 275 high-level waste canisters, two low-level radioactive waste canisters were generated while evacuating the melter. The vitrification process was shut down on September 5, 2002.

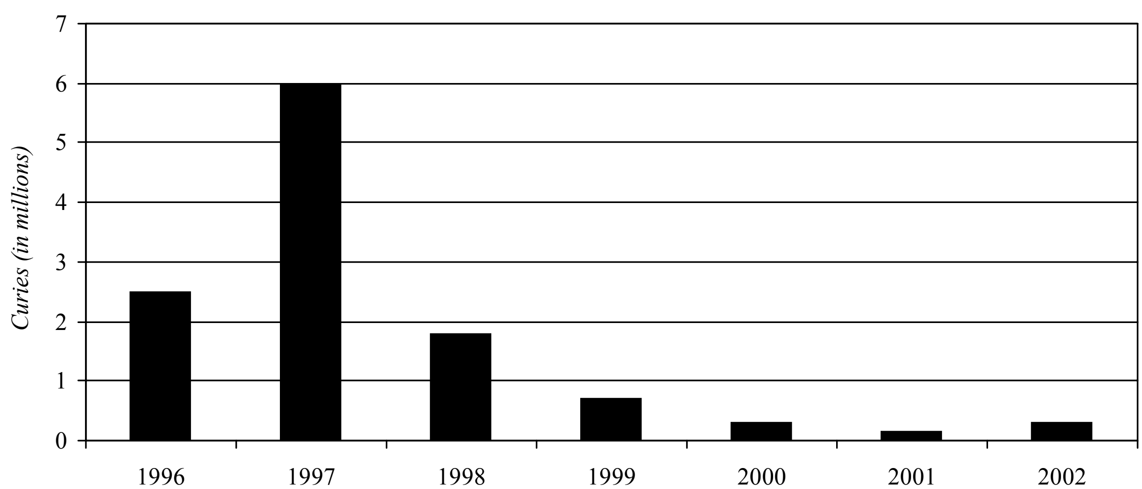

Figure 1-7. Number of Curies Transferred to the Vitrification Facility